*Available online a*t www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2013, 4(3):80-85

Pelagia Research Library

ISSN: 0976-8610
CODEN (USA): AASRFC

Comparative analysis of two indigenous Nigerian sands

P. N. Onwuachi-Iheagwara[1] and K. I. Idigbe[2]

[1]*Department of Petroleum and Gas Engineering, Delta State University, Abraka, Oleh campus, Oleh, Nigeria*
[2]*Department of Petroleum Engineering, University of Benin, Edo state, Nigeria*

ABSTRACT

This paper documents an analysis of the Ughelli and Benin sands. These sands are located in two adjacent states in the Niger delta of Nigeria; namely Delta and Edo states respectively. The mineralogical components of these two sands were examined. Slurries prepared from API grade G cements and stabilized with these sands were curried for 30 minutes at atmospheric conditions and the development of early compressive strength studied in an attempt to understand the use and effect of these sands in the prevention of cement retrogression in the Niger Delta. The investigation centred on the substitution of Silica flour; an additive in high temperature high pressure (HT HP) [1] cementation with indigenous sand. It was observed that Ughelli sands can be a substitute for the more expensive silica flour commonly used by the drilling companies in Nigeria to combat the effect of the cement retrogression in HT HP terrain in the country, especially in the Niger Delta Basin. Ughelli and Benin sands contain approximately 93 % and 90% silica respectively. At over 60 % substitution Ughelli sands can be used for HT HP operations in the Niger Delta. The compressive strengths analyses were conducted at 300 deg F in order to mimic the HT HP condition. These experiments showed that slurries prepared using Ughelli sands as additives had an acceptable compressive strength for HT HP usage.

Keywords: Benin sands, Ughelli sands, Niger Delta

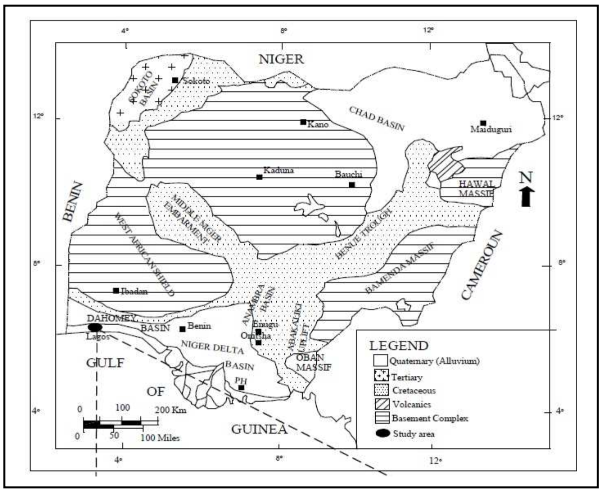
INTRODUCTION

Deposits of silica abound the width and breadth of Nigeria, for example the deposits in Ekrerhavhe community, Agbarho and in Ibi in Taraba State; well known deposits includes the deposits in Ughelli, Delta state, which lead to the development of the Beta Glass Company, and the Benin sands from the Benin formation; which is stratigraphically recognized as one of the three distinct facies belt (formations) of the tertiary Niger-Delta.

However, despite these and other deposits of high grade silica-rich material in the country, Nigeria still imports several silica-based substances used during exploitation of hydrocarbons; a good example is the silica flour used in high temperature high pressure (HT HP) cementation of geothermal wells in the Niger Delta. Millions of naira in hard currency can be saved if the indigenous silica can be a substitute for the imported variety. In this paper the deposits in Ughelli and Benin were considered.

THE CENOZOIC NIGER DELTA

The Niger Delta is one of the most prolific and economic sedimentary basins in Nigeria by virtue of the impact, size of the petroleum accumulations, discovered within it. Geological studies show that several depo-belts are bound in the Niger delta basin. [2] These depo-belts are zones of much deposition and are located onshore, continental shore and the deep/ ultra offshore.



Courtesy: www.indigopool.com © 2013

Figure 1 : The Sedimentary Basins in Nigeria [3]

The town of Benin and Ughelli are located in Edo and Delta states respectively and lie within the Niger Delta region. This paper focuses on the possible use of these sands for HT HP.

MATERIALS AND METHODS

SILICA FLOUR

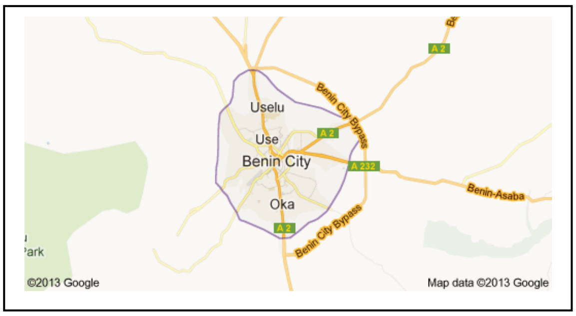
A common additive added for the prevention of cement retrogression in the Niger Delta is silica flour. Cement retrogression caused by the formation of lime-rich crystalline phase (alpha dicalcium-silicate hydrate), which weaken the mechanical strength of the cement materials. A weaken cement structure in the cement used to hold the casing to the well bore would lead to a loss of well control and an inability to maintain zonal isolation.

Cement design for geothermal applications have included 30 to 40% additional crystalline silica to help prevent loss of compressive strength and an increase in permeability in HP HT environments.[4]

The addition of silica allows for the formation of silica-rich cement phases (which do not result in strength retrogression) and have a high silicon-calcium ratio.

MINERALOGICAL ANALYSIS OF SAND

Sands samples were collected from the river Ughelli and from the Benin formation as exposed on the Benin bypass express road, Benin City, Edo state. These sands were washed, dried, treated and used to prepare thin section.



Courtesy: Google map

Figure 2: Benin bypass

Figure 3: Picture Showing Ughelli Beach and the Sand Collection Site

Figure 3: Picture showing Benin sands collection site

THIN-SECTION PREPARATION

For microscopic examination of the sands samples; after collection the samples were air- dried and impregnated using epoxy A and B. The impregnated samples were trimmed using the GTS cut- off saw. This ensured that a surface of the sample was made very flat. The flat surface was lapped on a glass plate using carborrundum of size 600 grid. One surface of a clean glass slide was also lapped on a glass slide. The lapped surface of the sample and that of the Slide was then bonded using epoxy, this is left to dry and the sample is later trimmed to 50 microns on the slide using cut-off saw.

The slide is then transferred to the CL50 lapping machine and the size of the sample reduced to 30 mirons. The slide was then covered using Canada balsam and cover –slid. The produced slides were studied under the petrographic microscope; under cross polarized and plane polarized light.

RESULTS AND DISCUSSION

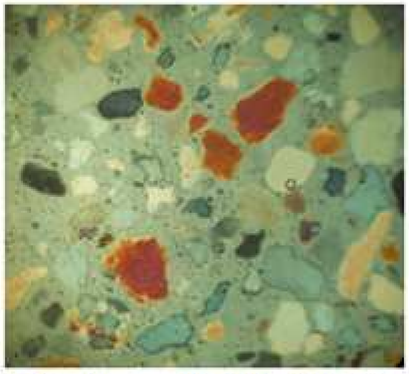


Figure 5: Photomicrographs of the Ughelli sands in cross polarized

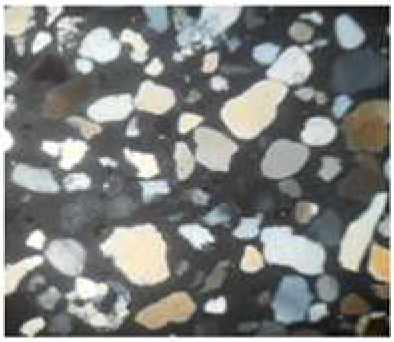


Figure 6: Photomicrographs of the Ughelli sands in plane polarized light

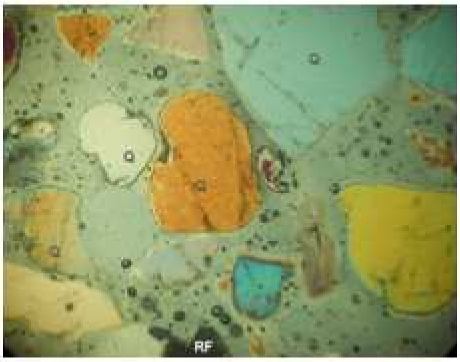


Figure 7: Photomicrographs of the Benin sands in cross polarized light

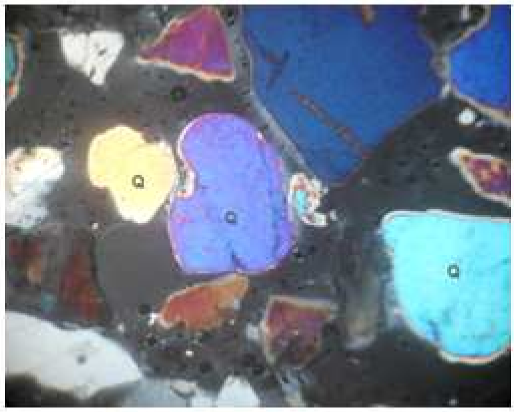


Figure 8: Photomicrographs of the Benin sands in plane polarized

A modal analysis of the sands showed that:

Table 1: The average modal analysis of the sands

Sand sample	Mono-crystalline	Poly-crystalline	% quartz	% feldspar	% heavy minerals	% matrix	% rock fragment
Benin sands	48	42	90	2	2	2	4
Ughelli sands	47	46	93	1	1	2	3

Table 2: General composition of each slurry

Sand	Slurry	Curing time, minutes	Experimental Temp. deg F	Ratio sand : API grade G cement
Benin sands	7BN to 12BN	30	300	30:70
Ughelli sands	7US to 12US	30	300	1:3
No sand. Only neat API G	7NA to 12NA	30	300	0 :100

Table 3: Experimental Data for Ughelli sand +API slurry

Sample Num	Curing temp., deg F	Silica flour, dry wt., gram	Ughelli sands, dry wt, gram	API grade G cement, dry wt, gram	Water Vol, ml	Exp. Pressure, Psi	Max. Load, KN	Compress. Strength, Psi
7US	75.2	2,080.00	6,500.00	19,500.00	1,200	5,000.00	4.6	0.5905
8US	75.2	2,080.00	6,500.00	19,500.00	1,200	6,000.00	5.8	0.7445
9US	75.2	2,080.00	6,500.00	19,500.00	1,200	7,000.00	7.6	0.9755
10US	75.2	2,080.00	6,500.00	19,500.00	1,200	8,000.00	8.2	1.0526
11US	75.2	2,080.00	6,500.00	19,500.00	1,200	9,000.00	9.3	1.1937
12US	75.2	2,080.00	6,500.00	19,500.00	1,200	10,000.00	12.4	1.5917

Table 4: Experimental Data for Benin sand + API cement slurries

Sample Number	Curing temp., deg F	Benin sands, dry wt., Kilogram	API Cement, dry wt., Kilogram	Water Vol, ml	Exp. Pressure, Psi	Max. Load, KN	Compress. Strength, Psi
7BN	75.2	1.47	3.43	1000	5000	6	0.77016
8BN	75.2	1.8	4.2	1000	6000	6	0.77016
9BN	75.2	2.31	5.39	1000	7000	6.4	0.82150
10BN	75.2	2.55	5.95	1000	8000	6.4	0.82150
11BN	75.2	2.859	6.671	1000	9000	6.4	0.82150
12BN	75.2	3.819	8.911	1000	10000	6.4	0.82150

Table 5: Experimental Data of neat API Grade G cement

Sample Number	Curing temp., deg F	dry wt. API G cement, kilogram	Vol. water, litre	Pressure, Psi	Max. Load, KN	Compress. Strength, Psi
7NA	75.2	5	1,000.00	5,000.00	5.53	0.7098
8NA	75.2	5	1,000.00	6,000.00	5.56	0.7137
9NA	75.2	5	1,000.00	7,000.00	5.7	0.7317
10NA	75.2	5	1,000.00	8,000.00	5.83	0.7483
11NA	75.2	5	1,000.00	9,000.00	5.87	0.7535
12NA	75.2	5	1,000.00	10,000.00	6.15	0.7894

Table 6: Approximate silica content in slurries

Slurry Mixture	Sample Number	Benin sand , gram	Ughelli sand, gram	Approx silica content gram
Benin sands +API	7BN-12BN	1,470-3,810	Nil	1323 – 3437
Neat API	7N A- 12NA	Nil	Nil	Nil
Ughelli sands +API	7US -12US	Nil	6,500	Approx. 6045

CONCLUSION

The early compressive strengths at 6000psi were practically the same for all the slurries.

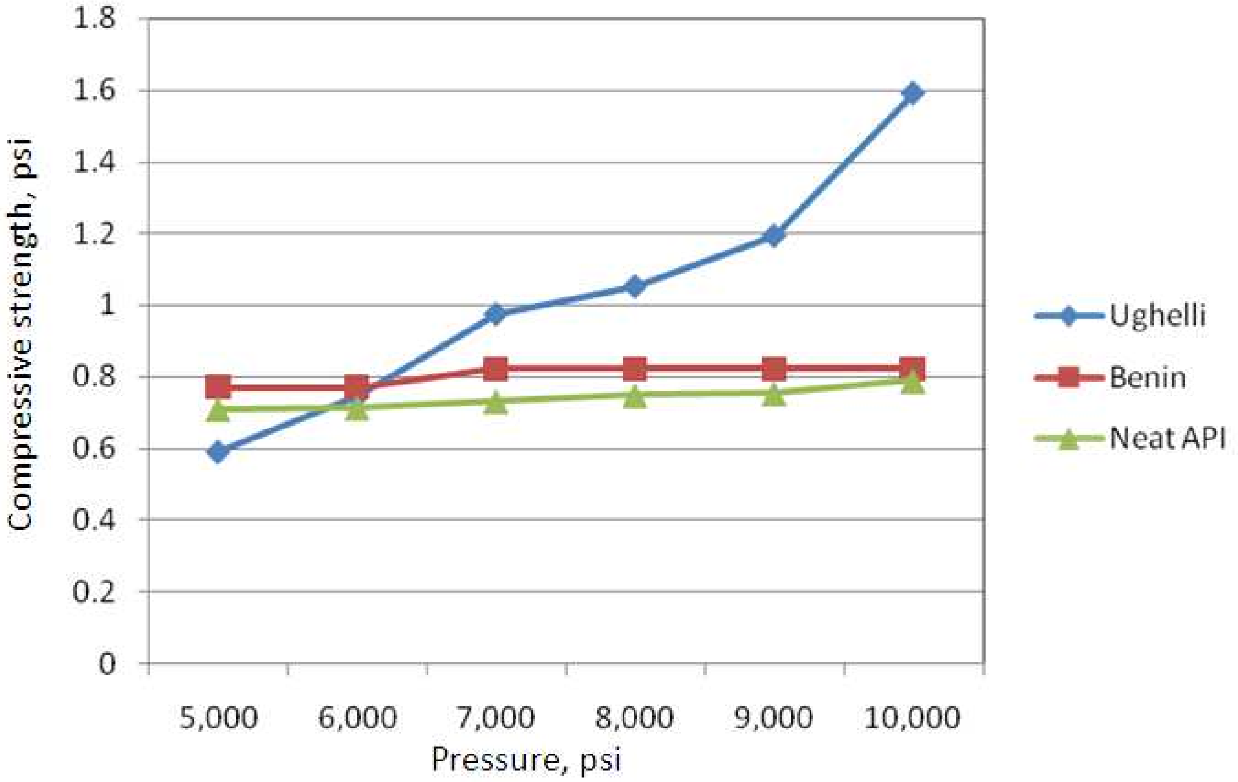


Figure 4: Compressive strength of each of the slurries

For the Benin sands with silica content of approximately 90% (without the addition of silica flour) the performances were poor at the temperature of investigation (300 deg F). With the extreme HT HP conditions in the Niger delta, the inadequacy of Benin sand-API grade G slurry is easily demonstrated; this however was not so with the Ughelli sand mixture. Slurry with Benin sands alone would definitely be unable to develop sufficient early compressive strength which is essential for zonal isolation and bonding of casing to wellbore.

The Ughelli sands with API grade G slurries shows more promising signs. The neat API grade G is however unsuitable for use without enrichment with silica.

Acknowledgments
The experimental data used in this study were produced during a study of oil field cement. The experiments were conducted in the laboratories of the Engineering Complex in the University of Benin, Edo state Nigeria.

REFERENCES

[1] Suhascaryo N, Nawangsidi D 2007; *The Composition Models Of Local Materials Additive To Light Weight Cement On Hp HT Conditions.* PROCEEDINGS, Thirty-Second Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, January 22-24, **2007** SGP-TR-183

[2] Egbai J.C. and Aigbogun, C.O. *Advances in Applied Science Research*, **2012**, 3 (2):656-670

[3] *Geology And Petroleum Potentials Of Nigeria Sedimentary Basins* , www.indigopool.com/nigeria/channel/pdf/GEOLOGY_OF_NIGERIA.pdf , p.3

[4] Salim P, Amani M,Special, *International Journal of Engineering and Applied Sciences*, **2013**, Vol.1, No 4.